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Residual Stress Measurement and Parametric Analysis of Laser Shock Peening of Aluminium Alloy 7075 with Different Thicknesses

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This work was aimed at the advancement of the Laser Shock Peening (LSP) process for aeronautical applications. This involved developing a robust strategy for residual stress measurements to various depths in LSP treated samples with different thicknesses and then to perform a parametric analysis of the LSP process.

For the residual stress measurement part of the study, aluminium alloy 7075 samples with thicknesses of 10, 6, 3 and 1.6 mm were treated with LSP and the residual stresses were measured using various complementary techniques: Incremental Hole Drilling (IHD), Neutron Diffraction (ND), Synchrotron Energy-Dispersive X-Ray Diffraction (ED-XRD), Laboratory XRD (L-XRD) and Synchrotron Angle-Dispersive XRD (AD-XRD). The results compared favourably and it was concluded that to obtain a complete depth profile in the subsequent work, the residual stresses would need to be measured using at least three methods: one for near the surface, one at intermediate depths and one at greater depths.

For the parametric analysis phase of the study, aluminium alloy 7075 samples with thicknesses of 10 and 1.6 mm were treated with LSP; the following LSP parameters were varied: Power Intensity (PI), Spot Size (SS) and %Overlap. The residual stresses were measured using L-XRD, IHD and ED-XRD. In addition to this, the following were investigated: the sample deformation, the surface integrity, the microhardness, and the microstructure under a Scanning Electron Microscope (SEM). A clear trend in the residual stress depth profile as well as the additional characterisations was observed as the parameters varied. This work will form part of a database of LSP results for various alloys that can be used for engineering residual stress profiles using optimal parameter selection for specific industrial applications and as benchmark for the development of LSP Finite Element tools.